

## CLAIMS

We claim:

1. A quantitative method for very high resolution, three-dimensional combined imaging of pulmonary ventilation (V) and perfusion (Q), synchronously (V/Q), wherein the method comprises delivering a predetermined volume of hyperpolarized noble gas into the conducting airways in each ventilated region of the pulmonary system and collecting local magnetic resonance image data therefrom to produce a V/Q image data set.
2. The method of claim 1, wherein the noble gas is hyperpolarized helium-3 gas (HP-<sup>3</sup>He).
3. The method of claim 2, further comprising three-dimensionally, quantitatively imaging absolute lung perfusion (Q) and collecting local magnetic resonance image data therefrom to produce absolute lung perfusion image data set.
4. The method of claim 3, wherein the imaging of absolute lung perfusion (Q) comprises a gadolinium based method.
5. The method of claim 3, wherein the imaging of absolute lung perfusion (Q) comprises an arterial spin-tagging method.
6. The method of claim 3, further comprising the step of using a co-registration algorithm to spatially co-register the HP-<sup>3</sup>He MR image V/Q data set with data set Q, comprising the quantitative perfusion in the lung.
7. The method of claim 6, further comprising dividing the lung image into as many distinct voxels as imaging resolution permits.
8. The method of claim 6, further comprising computing absolute ventilation (V) by multiplying the ventilation/perfusion ratio (V/Q) by perfusion (Q) for each point in the lung image.
9. The method of claim 8, wherein the method is applied to the pulmonary system of a mammalian subject.
10. The method of claim 9, wherein the mammalian subject is human.
11. The method of claim 10, wherein the lung is normal.
12. The method of claim 10, wherein the lung is injured or diseased.
13. The very high resolution, three-dimensional images of pulmonary ventilation, produced by the method of claim 8 using hyperpolarized HP-<sup>3</sup>He gas.

14. The system for producing the very high resolution, three-dimensional images of pulmonary ventilation (V) in the lung in accordance with claim 8, comprising:

- means for collecting and processing magnetic resonance imaging data from the hyperpolarized  $H^3He$  gas-infused lung, conducting airways and ventilated regions of the lung;
- means for dividing the lung images into as many distinct voxels as imaging resolution permits;
- means for synchronously imaging pulmonary ventilation (V) and perfusion (Q), and calculating V/Q therefrom;
- means for imaging of absolute lung perfusion and calculating Q therefrom;
- means for spatially co-registering the HP- $^3He$  MR image V/Q data set with data set Q for quantitative lung perfusion; and
- means for computing absolute ventilation (V) from the ventilation/perfusion ratio (V/Q) and perfusion (Q).

15. A device for post-acquisition processing of MRI-acquired high resolution, three-dimensional images of pulmonary ventilation (V) in the lung, comprising:

- computer-readable signal-bearing medium;
- means for collecting and processing magnetic resonance imaging data from a hyperpolarized  $H^3He$  gas-infused lung, conducting airways and ventilated regions of the lung;
- means for dividing the lung images into as many distinct voxels as imaging resolution permits;
- means for synchronously imaging pulmonary ventilation (V) and perfusion (Q), and calculating V/Q therefrom;
- means for imaging of absolute lung perfusion and calculating Q therefrom;
- means for spatially co-registering the HP- $^3He$  MR image V/Q data set with data set Q for quantitative lung perfusion; and
- means for computing absolute ventilation (V) from the ventilation/perfusion ratio (V/Q) and perfusion (Q).